

## STUDY PERFORMANCE REPORT

State: Michigan

Project No.: F-53-R-13

Study No.: 473

Title: Assessment of lake trout populations in Michigan waters of Lake Superior

Period Covered: April 1, 1996 to March 31, 1997

**Cooperators:** Thill Fisheries, Marquette, Michigan; Brey Fisheries and Vanlandschoot Fisheries, Munising, Michigan; United States Geological Service - Biological Resources Division (USGS-BRD), Ashland, Wisconsin; Chippewa/Ottawa Treaty Fisheries Management Authority (COTFMA), Sault Ste. Marie, Michigan; Red Cliff Fisheries Department, Bayfield, Wisconsin.

**Study Objective:** (1)To annually determine relative abundance, length and age composition, sex and maturity, sea lamprey wounding rates, growth, mortality rates, and total allowable catches (TACs) for hatchery (fin clipped) and wild (not fin clipped) lean-variety and siscowet-variety lake trout in Michigan's Lake Superior lake trout management areas. (2)To utilize these parameters in assessing effectiveness of sea lamprey control and progress of lean lake trout rehabilitation efforts in Michigan waters of Lake Superior. (3)To periodically determine what lake trout are eating, especially to document the switch from rainbow smelt to lake herring, and to determine if competition for food exists between the lean and siscowet varieties of lake trout. (4)To monitor lake herring abundance and age composition in lake trout habitat.

**Summary:** Abundance, as measured by CPE (number of fish per 1,000 feet of gill net per 72-hour set) of commercial sized ( $\geq 17$  in, total length), wild lean lake trout (leans) in 1996 ranged from 6.4 in MI-3 to 39.9 in MI-6. Wild fish made up 83-94% of leans in management areas MI-3, MI-4, MI-5, MI-6, and MI-7. Abundance of mature wild leans ( $\geq 25$  in, total length) in 1996 ranged from 1.3 in MI-3 to 7.6 in MI-6. Sea lamprey wounding (number of wounds per 100 fish) on the size group that represented most mature leans (25.0-28.9 in, total length) ranged from 6.4 in MI-6 to 32.5 in MI-4, and represented an increase in wounding compared to 1995. Wild leans represented 75-100% of pre-recruit leans ( $< 17$  in, total length) sampled in the pre-recruit assessment, and CPEs ranged from 1.0 in MI-6 to 9.6 in MI-5. Pre-recruit siscowet lake trout (siscowets) CPE ranged from 3.3 in MI-6 to 17.5 in MI-3. Lake herring was the most abundant species other than lake trout in the pre-recruit assessment. Compared to 1995, 1996 pre-recruit lean and siscowet lake trout CPEs decreased in most areas, but lake herring CPEs increased in all areas. Age of leans in the 1996 commercial-sized assessment ranged from 4 to 24 years and modal age ranged from 6 in MI-5 and MI-7 to 7 in MI-3, MI-4, and MI-6. Total annual mortality rates of 9- to 15-year-old wild lean lake trout in the commercial-sized assessment ranged from 0.41 in MI-3 to 0.58 in MI-6. Mean total weights (lb) and mean total lengths (in) of commercial-sized leans were 4.12 and 23.3 in MI-6 and 4.30 and 22.7 in MI-7. Pre-recruit wild leans were 3-9 years old, mean age ranged from 4.7 in MI-2 and MI-5 to 5.4 in MI-7, and modal age was 5 in all areas. Total annual mortality rates for all leans of ages 6-10 in the pre-recruit assessment ranged from 0.48 in MI-5 and MI-6 to 0.78 in MI-2. Mean lengths-at-age of leans in the pre-recruit assessment tended to be greater in MI-6 and MI-7 than in other areas. Pre-recruit siscowets were 3-16 years old, modal age was 8 in MI-2, MI-3, MI-4, and MI-5, and 5 in MI-6 and MI-7, and mean age ranged from 5.3 in MI-7 to 7.8 in MI-3. Siscowet total annual

mortality, estimated for ages 10-20, ranged from 0.22 in MI-2 and MI-4 to 0.28 in MI-6. Siscowet length-at-age was generally greater in MI-6 and MI-7 than in other areas.

**Job 1. Title: Assess commercial-sized lake trout stocks.**

**Findings:** Assessment fishing for commercial-sized ( $\geq 17$  inches, total length) lean lake trout (hereafter referred to as leans) was done by contracted commercial fishers at four stations (Big Bay, Marquette, Munising-west, Munising-east), by Marquette Fisheries Station at four stations (Upper Entry, Bete Grise, Traverse Island, Point Abbaye), and by Chippewa/Ottawa Treaty Fisheries Management Authority (COTFMA) at one station (Grand Marais) during 20 May to 16 June 1996. Start date was three weeks later than normal due to prolonged ice cover on Lake Superior. Assessment nets were 1,500- or 3,000-foot gangs of 4.5-inch stretched mesh multifilament gill net fished 72 hours on the bottom in 120-240 feet of water. In general, successive net sets were made at sites associated with each station until a quota of commercial-sized lake trout was captured. Fish quotas were 500 fish per station in management area MI-5 (Big Bay and Marquette), and 400 fish per station in area MI-6 (Munising-west and Munising-east). Time constraints prevented collecting a quota of 500 lake trout at each of the five stations included in areas MI-3 and MI-4, so an amount of gill-net effort (feet) based on time constraints has been fished at each station annually in recent years as follows: 45,000 at Upper Entry (MI-3), 15,000 at each of MI-4 stations Bete Grise, Traverse Island and Point Abbaye. Personnel from COTFMA fished 24,000 feet of net at Grand Marais (MI-7) in 1996. Marquette Fisheries Station personnel collected data from all assessment catches in MI-3, MI-4, MI-5, and MI-6, and COTFMA personnel collected data from catches in MI-7. Data consisted of the following for commercial-sized leans captured in each 1,500 feet of net: number, fin clip, total length, sex, number of sea lamprey wounds (combined total of stages A1, A2, and A3) and scars (combined total of stages A4, B1, B2, B3, and B4). Scale samples were taken from all leans, and otoliths from all leans 23 inches and longer, except in MI-3 and MI-4 where an otolith sample was obtained from all leans. Diet data were obtained for at least 100 net-run leans from each management area. Total weights were obtained from 100 net-run leans in MI-6 only. Marquette Fisheries Station personnel determined the number of leans per 1,000 feet of net per 72-hour set (CPE) as a measure of abundance, determined age from scales and otoliths, calculated mortality rates from age composition, and summarized sea lamprey wounding. USGS-BRD personnel from the Ashland Biological Station in Ashland, Wisconsin analyzed diet data. Commercial-sized leans were assessed in MI-2 in 1996 by the Red Cliff Fisheries Department, Red Cliff Band of Lake Superior Chippewas, Bayfield, Wisconsin. These data were analyzed by Red Cliff Fisheries Department and are available in a report by Gallinat (1997).

The CPE of hatchery leans was highest in MI-5 (5.4) and lowest in MI-3 (0.6) (Table 1). Wild leans made up 83-94% of the populations in the management areas, and were most abundant in MI-6 (39.9) and least abundant in MI-3 (6.4). The CPE of mature ( $\geq 25$  inches, total length) wild leans ranged from 1.0 in MI-3 to 7.6 in MI-6. Compared to 1995, CPE of wild leans in 1996 was down slightly in MI-3, MI-4 and MI-5, and increased in MI-6 and MI-7.

Sea lamprey wounding (number of wounds per 100 fish) on leans in the inch group that represented most mature fish (25.0-28.9 in) ranged from 6.4 in MI-6 to 32.5 in MI-4 (Table 1). Compared to 1995, wounding on this size group in 1996 increased in all areas. Wounding was lower on smaller lean lake trout, ranging from 2.0 (MI-6) to 6.7 (MI-7) for the 21.0-24.9 inch group, and 0.0 (MI-3, MI-4, and MI-5) to 1.8 (MI-7) for the 17.0-20.9 inch group.

**Job 2. Title: Assess pre-recruit lake trout.**

**Findings:** Marquette Fisheries Station personnel assessed pre-recruit (<17 inches, total length) lake trout populations at 25 stations between Black River Harbor (MI-2) and Grand Marais (MI-7) during 31 July-28 August 1996. One or two 1,800-foot gangs of graded-mesh (6-foot by-300 foot panels of 2.0-, 2.25-, 2.5-, 2.75-, 3.0-, and 3.5-inch stretch mesh) multifilament nylon gill nets were fished on the bottom at depths of 60-260 feet for 24 hours at each station. Two gangs were usually fished, but only one gang was fished at a few stations where the target depth range of 90 to 240 feet could be spanned with 1,800 feet. Data collected from leans, siscowet lake trout (hereafter referred to as siscowets), and other trout and salmon in the pre-recruit assessment were the same as from leans in the commercial-sized assessment except that maturity was assessed. Individual total weights of leans and siscowets were measured in each management area, with a quota of 50 pre-recruit leans and 50 pre-recruit siscowets. Otoliths were taken from leans 23 inches and larger and from all siscowets regardless of size. Although this assessment was targeted at pre-recruit lake trout, larger lake trout were captured. These larger lake trout were included in analyses of age distribution and mean length-at-age. No samples to assess diet were collected from leans and siscowets in this assessment. Total length, total weight, and scale samples from 10 fish per mesh size per gang were obtained for all other species except that only total length was recorded for suckers, rainbow smelt, burbot, alewife, carp, and lake sturgeon. The CPE (number per 1,000 ft of gill net per 24 hours) was calculated for all species and pre-recruit-sized leans and siscowets. The CPEs of pre-recruit leans, pre-recruit siscowets, and lake herring in 2.0-inch and 2.5-inch mesh were also calculated because those mesh sizes were common to pre-recruit assessment gill nets used by all state, federal, tribal, and provincial agencies on Lake Superior.

The representation of wild leans in pre-recruit lean populations ranged from 75% in MI-6 to 100% in MI-7 (Table 2). Wild pre-recruit lean CPEs in all meshes ranged from 1.0 in MI-6 to 9.6 in MI-5, and hatchery lean CPEs ranged from 0.0 in MI-7 to 1.8 in MI-2. The CPEs were slightly higher in 2.0- and 2.5-in mesh, with wild lean CPEs ranging from 1.0 in MI-7 to 11.2 in MI-5, and those for hatchery leans ranging from 0.0 in MI-7 to 2.2 in MI-2. Pre-recruit siscowet CPEs in all meshes ranged from 3.3 in MI-6 to 17.5 in MI-3, and CPEs in 2.0- and 2.5-in mesh ranged from 2.0 in MI-6 to 19.1 in MI-3. Pre-recruit siscowets were more abundant than wild leans in all meshes in MI-3, MI-6, and MI-7, but less abundant in MI-2, MI-4, and MI-5. Sea lamprey wounding was rarely observed on pre-recruit leans or siscowets. Compared to 1995, wild pre-recruit lean CPEs in 1996 were lower in all areas. Pre-recruit siscowet CPE increased in MI-2, was about the same in MI-3, but decreased in the other areas.

Lake herring was the most abundant species other than lake trout in the pre-recruit assessment. Lake herring CPEs in all meshes ranged from 2.9 in MI-7 to 59.5 in MI-2 (Table 3), and CPE in 2.0- and 2.5-inch mesh ranged from 2.9 in MI-7 to 140.7 in MI-2. Other species in order of abundance were round whitefish, lake whitefish, longnose sucker, bloater, rainbow smelt, burbot, and kiyi. Compared to 1995, CPEs in 1996 increased substantially for lake herring and round whitefish but decreased or remained about the same for other species.

**Job 3. Title: Assess spawning lake trout.**

**Findings:** No work was done on this job.

**Job 4. Title: Determine age, growth, mortality, total allowable catch (TAC), and food habits.**

**Findings:** Marquette Fisheries Station personnel determined age of wild leans in the commercial-sized assessment from a subsample of 20 fish per inch group from scales or otoliths. Age composition in each inch group subsample was applied to the total number of wild leans in those inch groups to estimate total age composition. Ages were determined for all commercial-sized hatchery leans based on fin clip and scale or otolith age. Ages were determined for all leans and siscowets in the pre-recruit assessment. Confidence intervals ( $\pm 95\%$ ) were determined for mean age, mean weight, mean total length, and weight-length coefficients for weights and lengths transformed to natural logarithms. These means and coefficients were compared between leans and siscowets and among management areas, with non-overlapping confidence intervals indicating a significant difference ( $P \leq 0.05$ ). Total mortality rates for commercial-sized and pre-recruit wild leans in each management area were estimated by the method described by Robson and Chapman (1961) based on number of fish in age groups on the descending limb of the catch curve that are judged to be fully vulnerable to the gill nets. Chi-square values were calculated to compare two separately estimated survival rates in the Robson Chapman method. According to Robson and Chapman (1961), a chi-square in excess of 3.84 indicated that there was greater than a 5% chance that factors other than sampling error were compromising validity of mortality rates estimated from the age composition data. These factors could include variable recruitment, variable survival among ages, or unequal vulnerability to sampling gear.

Total allowable catches (TACs) for commercial-sized leans in Lake Superior management areas are being updated but are not available for this report.

Age distribution of wild leans in the 1996 commercial-sized assessment ranged from 4 to 24 years and the mean age ranged from 7.3 years in MI-6 to 7.6 years in MI-5 and MI-7 (Table 4). Mean ages in 1996 were similar to ages in 1995, except that mean age was lower in MI-6. Age 7 was modal in all areas except MI-3 where age 6 was modal. The Great Lakes Fishery Commission's Lake Superior Technical Committee has elected to use mean total length at age 7 as an annual index of wild lean growth. Mean total length of age-7 wild leans ranged from 21.1 inches in MI-4 to 23.0 inches in MI-3. Compared to 1995, mean length of age-7 wild leans increased in all areas except MI-4, but the increase was significant only for fish in MI-3. Age 8 has been determined to be the youngest age fully vulnerable to the 17-inch minimum size limit in the commercial-sized assessment. To insure vulnerability and comparability among management areas and years, ages 9-15 were selected for mortality rate calculations. Total annual mortality rates ranged from 0.41 in MI-3 to 0.58 in MI-6 (Table 4). Chi-square values were within the 5% level (chi-square  $\leq 3.84$ ) using age groups 9-15 in MI-3, MI-4, and MI-5, but not in MI-6 and MI-7. Acceptable chi-square values were obtained in these areas using ages 8-15 with slightly higher mortality rates of 0.58 in MI-6 and 0.54 in MI-7. Compared to 1995, mortality rates from ages 9-15 in 1996 decreased in MI-3 and MI-5, increased in MI-6 and MI-7, and remained the same in MI-4. Mean weight of commercial-sized leans was 4.12 lb in MI-6 and 4.30 lb in MI-7, and mean total length was 23.3 and 22.7 inches respectively (Table 5). Weight-length coefficients for lean lake trout were not significantly different ( $P \leq 0.05$ ) between the two areas.

Age of all wild leans in the pre-recruit assessment ranged from 3 to 13 years, with a modal age of 5 in MI-2, MI-3, and MI 5, a modal age of 6 in MI-4 and MI-6, and a modal age of 7 MI-6 (Table 6). Mean age of all leans ranged from 5.0 in MI-2 to 6.7 in MI-6. Mean ages in 1996 were similar to those in 1995. Pre-recruit lean ages ranged from 3 to 9. Age 5 was the pre-recruit modal age in all areas except MI-5 where age 4 was modal. Mean ages ranged from 4.7

in MI-2 and MI-5 to 5.4 in MI-7, and were similar to those reported in 1995. Total annual mortality rates estimated from the total catch of all leans within ages 6-10 ranged from 0.48 in MI-5 and MI-6 to 0.78 in MI-2. Chi-square values for all areas except MI-4 and MI-7 were within the 5% level (chi-square  $\leq 3.84$ ). Pre-recruit lean lake trout mean weight and mean length was greater in MI-6 and MI-7 than in other management areas, and weight-length coefficients varied among areas (Table 5). Some of this variation among areas was likely due to differences in sample size. Values for weight and length parameters from the total sample in 1996 were not different from values in 1995. There were few significant differences in mean total length-at-age of wild leans among management areas, but means were generally larger in MI-6 and MI-7 than in other areas (Table 7).

Age of all siscowets in the pre-recruit assessment ranged from 3 to 32 years, modal age was 8 in all areas, and mean age ranged from 8.8 in MI-7 to 11.1 in MI-2 (Table 8). Pre-recruit siscowets ranged in age from 3 to 16 years, modal age was 8 in all areas except it was 5 in MI-6 and MI-7, and mean age ranged from 5.3 in MI-7 to 7.8 in MI-3. Siscowet mean ages in management areas in 1996 were similar to those in 1995. Total annual mortality rates estimated for ages 10-20 in 1996 tended to be lower than in 1995 and ranged from 0.22 in MI-2 and MI-4 to 0.28 in MI-6. Pre-recruit siscowet mean total length, mean weight, and weight-length coefficients in 1996 were variable with some differences noted among areas, but values for these parameters were not different than those for pre-recruit leans (Table 5). Mean length and weight of pre-recruit siscowets in the 1996 total sample from all areas was less than in 1995, but weight-length coefficients were similar. Siscowet mean total length-at-age in 1996 was generally greater in MI-6 and MI-7 than in the other areas (Table 9), and significantly less than for comparable ages of lean lake trout (Table 8).

**Job 5. Title: Prepare reports.**

**Findings:** Data from this study were used to prepare the annual report to the Lake Superior Committee of the Great Lakes Fishery Commission, and to prepare this Federal Aid for Sport Fish Restoration Annual Performance Report.

**Literature Cited:**

- Gallinat, M. P. 1997. Results of the 1996 spring lake trout assessment in management unit MI-2 of Lake Superior. Red Cliff Fisheries Department, Assessment Report 97-2, Bayfield, WI.
- Robson, D. S. and D. G. Chapman. 1961. Catch curves and mortality rates. Transactions of the American Fisheries Society 90:181-189.

Table 1.—Commercial-sized ( $\geq 17$  in, total length) lean lake trout assessment effort, abundance (CPE)<sup>a</sup> and sea lamprey wounding<sup>b</sup> at stations in Michigan's Lake Superior management areas 3-7 during 20 May-16 June 1996.

Management area and station	Effort (ft x 1,000)	CPE				Wounds per 100 lake trout and number of fish in parentheses Total length (in) groups			
		Hatchery	Wild		Total (% wild)	17.0- 20.9	21.0- 24.9	25.0- 28.9	$\geq 29.0$
			All	$\geq 25$ in					
<b>MI-3</b>									
Upper Entry	45.0	0.6	6.4	1.0	7.0 (91)	0.0 (96)	5.4 (165)	28.0 (50)	0.0 (5)
<b>MI-4</b>									
Bete Grise	15.0	2.0	11.9	2.2	13.9 (86)	0.0 (83)	3.3 (91)	31.2 (32)	0.0 (3)
Traverse Island	15.0	2.6	12.9	1.9	15.5 (83)	0.0 (71)	5.5 (128)	26.7 (30)	0.0 (3)
Point Abbaye	15.0	0.3	13.1	1.3	13.4 (98)	0.0 (86)	3.2 (94)	46.7 (15)	0.0 (6)
Area total	45.0	1.6	12.6	1.8	14.3 (88)	0.0 (240)	4.2 (313)	32.5 (77)	0.0 (12)
<b>MI-5</b>									
Big Bay	12.0	7.1	39.3	6.4	46.4 (85)	0.0 (132)	2.6 (341)	12.5 (72)	25.0 (12)
Marquette	21.0	4.4	19.7	6.6	24.1 (82)	0.0 (47)	2.8 (289)	4.1 (146)	8.3 (24)
Area total	33.0	5.4	26.8	6.5	32.2 (83)	0.0 (179)	2.7 (630)	6.9 (218)	13.9 (36)
<b>MI-6</b>									
Munising-west	4.5	8.2	58.4	11.8	66.7 (88)	1.2 (85)	0.6 (157)	6.0 (50)	25.0 (8)
Munising-east	4.5	1.1	21.3	3.3	22.4 (95)	0.0 (36)	6.2 (48)	7.7 (13)	0.0 (4)
Area total	9.0	4.7	39.9	7.6	44.6 (90)	0.8 (121)	2.0 (205)	6.4 (63)	16.7 (12)
<b>MI-7</b>									
Grand Marais	24.0	1.1	17.0	3.4	18.1 (94)	1.8 (110)	6.7 (239)	12.5 (80)	16.7 (6)

<sup>a</sup> Number of commercial-sized lake trout per 1,000 feet of 4.5-inch mesh-multifilament gill net.

<sup>b</sup> Number of stage A1, A2, and A3 sea lamprey marks per 100 lake trout.

Table 2.—Pre-recruit (<17 in, total length) lean and siscowet lake trout abundance (CPE)<sup>a</sup> assessed<sup>b</sup> in Michigan's Lake Superior management areas 2-7 during 31 July-28 August 1996.

Area	Variety	CPE (All meshes)			CPE (2.0- and 2.5-inch mesh)		
		Effort (ft x 1,000)	Wild ( % wild)	Hatchery	Effort (ft x 1,000)	Wild	Hatchery
MI-2	Lean	10.8	5.9 (77)	1.8	3.6	8.0	2.2
	Siscowet		4.1			5.4	
MI-3	Lean	14.2	4.9 (80)	1.2	4.7	5.4	1.3
	Siscowet		17.5			19.1	
MI-4	Lean	25.2	8.3 (83)	1.7	8.4	7.8	1.8
	Siscowet		7.5			8.4	
MI-5	Lean	14.4	9.6 (88)	1.3	4.8	11.2	1.6
	Siscowet		6.8			7.0	
MI-6	Lean	14.4	1.0 (75)	0.3	4.8	1.5	0.3
	Siscowet		3.3			2.0	
MI-7	Lean	7.2	2.3 (100)	0.0	2.4	1.0	0.0
	Siscowet		3.7			4.9	

<sup>a</sup> Number of lake trout per 1,000 feet of gill net.

<sup>b</sup> Assessment nets were gill nets made up of 300-foot panels of 2.0-, 2.25-, 2.5-, 2.75-, 3.0-, and 3.5-inch multifilament nylon mesh.

Table 3.—Abundance (CPE)<sup>a</sup> of fish other than lean and siscowet lake trout in the pre-recruit lake trout assessment<sup>b</sup> in Michigan's Lake Superior management areas 2-7, 31 July-28 August 1996.

Species	Management area and effort (thousands of feet of gill net)						Total (86.2)
	MI-2 (10.8)	MI-3 (14.2)	MI-4 (25.2)	MI-5 (14.4)	MI-6 (14.4)	MI-7 (7.2)	
Lake herring	59.5	33.5	29.6	6.9	10.7	2.9	19.6
Bloater	2.6	1.0	1.2	0.3	1.1	0.2	0.9
Kiyi	0.1	0.3			0.1	0.2	0.1
Lake whitefish	3.5	13.8	0.1	0.2	5.2		2.9
Round whitefish	2.3	6.6	3.7	13.9	2.6	0.5	4.4
Longnose sucker	0.8	1.8	2.2	0.8	7.4		1.9
Rainbow smelt	1.3	0.6	2.8				0.9
Burbot	0.1	0.7	1.7	0.7	0.3	0.2	0.6

<sup>a</sup> Number of fish per 1,000 feet of gill net.

<sup>b</sup> Assessment gill nets were made up of 300-foot panels of 2.0-, 2.25-, 2.5-, 2.75-, 3.0-, and 3.5-inch multifilament nylon mesh.



Table 4.—Age composition (number), mean age, and mean total length at age 7  $\pm$ 95% confidence intervals (CI), and total annual mortality<sup>a</sup> (A) of wild lean lake trout captured in the assessment<sup>b</sup> of commercial-sized lean lake trout ( $\geq$ 17 in, total length) in Michigan's Lake Superior management areas 3-7 during 20 May-16 June 1996.

Age (year)	Management area				
	MI-3	MI-4	MI-5	MI-6	MI-7
4		3	7	1	
5	13	14	33	10	6
6	112	157	196	93	71
7	72	208	335	138	159
8	37	79	112	53	89
9	21	52	80	27	53
10	8	30	47	31	9
11	10	10	30	4	9
12	7	5	22	2	6
13	1	5	7		1
14	4	2	6		4
15		1	6		
16+	3	2	4		2
Total	288	568	885	359	409
Mean age	7.4	7.4	7.6	7.3	7.6
CI	0.2	0.1	0.1	0.1	0.2
Age-7 length	23.0	21.1	21.9	21.6	22.2
CI	0.6	0.6	0.6	0.6	0.7
Mortality					
Ages	9-15	9-15	9-15	9-15	9-15
A	0.41	0.51	0.42	0.58	0.54
Chi-square	0.0094	0.1215	0.5863	15.8235	7.8675

<sup>a</sup> Mortality determined by the Robson-Chapman method.

<sup>b</sup> Assessment nets were 4.5-inch multifilament nylon mesh gill nets.

Table 5.—Mean weight, mean total length, and the weight-length coefficients for lean and siscowet lake trout captured in the commercial-sized ( $\geq 17$  in, total length) assessment<sup>a</sup> during 20 May–16 June 1996, and pre-recruit ( $< 17$  in, total length) assessment<sup>b</sup> during 31 July–28 August 1996 in Michigan's Lake Superior management areas ( $\pm 95\%$  confidence intervals (CI) on means and coefficients).

Area	N	Mean weight (lb) $\pm 95\%$ CI	Mean total length (in) $\pm 95\%$ CI	Log <sub>e</sub> total weight (lb) log <sub>e</sub> total length (in) coefficients $\pm 95\%$ CI		R <sup>2</sup>
				a	b	
<b>Commercial-sized lean lake trout</b>						
MI-6	100	4.12 $\pm$ 0.32	23.3 $\pm$ 0.5	3.36 $\pm$ 0.19	-9.20 $\pm$ 0.60	0.93
MI-7	432	4.30 $\pm$ 0.16	22.7 $\pm$ 0.2	3.14 $\pm$ 0.09	-8.42 $\pm$ 0.28	0.92
<b>Pre-recruit lean lake trout</b>						
MI-2	53	0.89 $\pm$ 0.06	14.8 $\pm$ 0.3	3.32 $\pm$ 0.46	-9.08 $\pm$ 1.25	0.80
MI-3	51	0.66 $\pm$ 0.07	13.6 $\pm$ 0.4	2.99 $\pm$ 0.34	-8.27 $\pm$ 0.88	0.87
MI-4	109	0.85 $\pm$ 0.07	14.4 $\pm$ 0.4	3.13 $\pm$ 0.11	-8.57 $\pm$ 0.30	0.96
MI-5	63	0.88 $\pm$ 0.06	14.9 $\pm$ 0.4	2.95 $\pm$ 0.21	-8.12 $\pm$ 0.56	0.93
MI-6	16	0.98 $\pm$ 0.14	14.9 $\pm$ 0.7	2.93 $\pm$ 0.69	-7.96 $\pm$ 1.84	0.86
MI-7	14	1.05 $\pm$ 0.07	15.7 $\pm$ 0.4	1.95 $\pm$ 0.88	-5.33 $\pm$ 2.42	0.66
Total	307	0.85 $\pm$ 0.04	14.5 $\pm$ 0.2	3.11 $\pm$ 0.10	-8.52 $\pm$ 0.26	0.92
<b>Pre-recruit siscowet lake trout</b>						
MI-2	18	0.93 $\pm$ 0.12	15.2 $\pm$ 0.6	2.98 $\pm$ 0.65	-8.21 $\pm$ 1.78	0.85
MI-3	70	0.85 $\pm$ 0.06	14.9 $\pm$ 0.4	3.29 $\pm$ 0.17	-9.08 $\pm$ 0.47	0.95
MI-4	90	0.84 $\pm$ 0.07	14.3 $\pm$ 0.4	3.16 $\pm$ 0.19	-8.67 $\pm$ 0.51	0.93
MI-5	81	0.77 $\pm$ 0.06	14.3 $\pm$ 0.4	2.94 $\pm$ 0.16	-8.12 $\pm$ 0.42	0.94
MI-6	39	0.91 $\pm$ 0.08	14.9 $\pm$ 0.5	2.73 $\pm$ 0.33	-7.50 $\pm$ 0.89	0.88
MI-7	23	1.08 $\pm$ 0.13	15.4 $\pm$ 0.5	2.99 $\pm$ 0.52	-8.15 $\pm$ 1.44	0.87
Total	322	0.85 $\pm$ 0.03	14.6 $\pm$ 0.2	3.08 $\pm$ 0.10	-8.47 $\pm$ 0.27	0.92

<sup>a</sup> Commercial-sized assessment gill nets were 4.5-inch multifilament nylon mesh fished in management areas 3-7.

<sup>b</sup> Pre-recruit assessment gill nets were made up of 300-foot panels of 2.0-, 2.25-, 2.5-, 2.75-, 3.0-, and 3.5-inch multifilament nylon mesh fished in management areas 2-7.

Table 6.—Age composition (number), mean age  $\pm$ 95% confidence intervals (CI), and total annual mortality<sup>a</sup> (A) of all and pre-recruit (PreR) wild lean lake trout captured in the assessment of pre-recruit (<17 in, total length) lake trout<sup>b</sup> in Michigan's Lake Superior management areas 2-7 during 31 July-28 August 1996.

Age (year)	Management areas											
	MI-2		MI-3		MI-4		MI-5		MI-6		MI-7	
	All	PreR	All	PreR	All	PreR	All	PreR	All	PreR	All	PreR
3	2	2	4	4	10	10	13	13	1	1		
4	14	14	15	15	27	27	43	43	3	2	3	2
5	28	26	26	25	44	40	47	42	7	6	9	6
6	13	7	12	8	55	36	34	18	13	3	18	4
7			8	2	43	7	28	7	11		21	2
8	2		5		21	3	8		10		2	
9			1		7		8	1	1		2	
10			1		3		5		1			
11			1		1		2		1			
12			1				1		1			
13					1							
Total	59	49	74	54	212	123	189	124	49	12	55	14
Mean age	5.0	4.7	5.6	4.8	6.0	5.1	5.6	4.7	6.7	4.9	6.3	5.4
CI	0.2	0.2	0.4	0.2	0.2	0.2	0.2	0.2	0.5	0.6	0.3	0.5
Mortality rates (A) for ages 6-10												
A	0.78		0.51		0.52		0.48		0.48		0.58	
Chi-square	2.71		0.86		9.33		3.30		3.62		9.59	

<sup>a</sup> Mortality determined by the method described by Robson and Chapman (1961).

<sup>b</sup> Assessment nets were gill nets made up of 300-foot panels of 2.0-, 2.25-, 2.5-, 2.75-, 3.0-, and 3.5-inch multifilament nylon mesh.

Table 7.—Mean total length (in)  $\pm$ 95% confidence intervals (CI) and length range for principal ages of wild lean lake trout in the assessment of pre-recruit lake trout<sup>a</sup> in Michigan's Lake Superior management areas 2-7, 31 July-28 August 1996.

Management areas and parameters	Age (years)							
	3	4	5	6	7	8	9	10
<b>MI-2</b>								
Number	2	14	28	13		2		
Mean length	12.2	13.6	15.3	16.6		25.5		
$\pm$ 95% CI	3.6	0.8	0.5	0.9		18.0		
Length range	11.8-12.6	11.0-16.4	13.3-18.2	14.3-19.5		23.5-27.5		
<b>MI-3</b>								
Number	4	15	26	12	8	5	1	1
Mean length	11.2	13.0	14.8	16.4	17.7	20.5	26.2	25.0
$\pm$ 95% CI	1.0	0.5	0.5	1.4	2.5	2.7		
Length range	10.6-12.2	11.8-15.0	12.2-18.5	12.3-21.1	13.3-23.8	17.2-23.8		
<b>MI-4</b>								
Number	10	27	44	55	43	21	7	3
Mean length	11.3	13.3	15.6	16.8	18.7	19.3	20.4	19.5
$\pm$ 95% CI	0.6	0.7	0.3	0.5	0.7	1.2	3.4	2.0
Length range	10.1-12.5	9.7-16.9	13.1-18.1	13.3-24.0	14.8-25.1	15.5-28.0	17.5-29.1	18.7-20.6
<b>MI-5</b>								
Number	13	43	47	34	28	8	8	5
Mean length	11.8	13.5	15.2	16.8	18.7	22.2	22.1	25.9
$\pm$ 95% CI	0.9	0.4	0.4	0.4	1.0	2.9	3.7	3.0
Length range	10.0-15.0	11.-16.8	12.8-20.8	13.0-19.2	15.4-25.8	17.5-26.6	16.9-29.5	22.9-29.0
<b>MI-6</b>								
Number	1	3	7	13	11	10	1	1
Mean length	11.3	15.1	15.6	17.6	19.5	21.6	22.0	24.5
$\pm$ 95% CI		4.7	0.7	0.6	1.2	2.7		
Length range		12.6-17.2	14.7-17.0	15.1-19.0	17.3-24.1	17.2-28.8		
<b>MI-7</b>								
Number		3	9	18	21	2	2	
Mean length		16.4	16.4	17.4	18.9	22.0	21.5	
$\pm$ 95% CI		3.2	1.0	0.4	0.9	2.7	0.9	
Length range		15.4-18.2	14.2-18.5	15.2-18.7	14.9-23.6	21.7-22.3	21.4-21.6	

<sup>a</sup> Assessment nets were gill nets made up of 300-foot panels of 2.0-, 2.25-, 2.5-, 2.75-, 3.0-, and 3.5-inch multifilament nylon mesh.

Table 8.—Age composition (number), mean age  $\pm$ 95% confidence intervals (CI), and total annual mortality<sup>a</sup> (A) of all and pre-recruit (PreR) siscowet lake trout captured in the assessment<sup>b</sup> of pre-recruit lake trout (<17 in, total length) in Michigan's Lake Superior management areas 2-7 during 31 July-28 August 1996.

Age (year)	Management areas											
	MI-2		MI-3		MI-4		MI-5		MI-6		MI-7	
	All	PreR	All	PreR	All	PreR	All	PreR	All	PreR	All	PreR
3	2	2	1	1	6	6	3	3	2	2		
4			6	6	13	13	6	6	3	3	4	4
5	4	4	7	7	16	15	11	11	16	11	12	11
6	6	6	30	29	19	18	19	19	7	5	9	5
7	4	4	34	31	9	8	10	7	13	9	6	1
8	11	8	68	56	59	42	25	19	18	6	14	1
9	3	2	38	27	35	21	24	8	16	1	9	
10	8	3	47	22	28	10	13	4	14		7	
11	8	3	23	5	21	7	12	1	15		7	
12	4		32	3	28	2	23	6	7		4	
13	8		35	1	28		18	1	7		2	
14	6		25		34		12		10		4	
15	8		31		26		21		7		4	
16	3	1	20		23	1	5		3			
17	4		13		12		4		1			
18	1		3		1		2		1			
19	1		6		2							
20+	2				4		1		1		2	
Total	83	33	419	188	364	143	209	85	141	37	84	22
Mean age	11.1	7.6	10.6	7.8	10.7	7.3	10.3	7.2	9.6	6.0	8.8	5.3
CI	0.9	0.9	0.3	0.2	0.4	0.4	0.5	0.5	0.6	0.5	0.8	0.4
Mortality rates of lake trout within ages 10-20.												
A	0.22		0.24		0.22		0.24		0.28		0.27	
Chi-square	1.69		2.85		11.87		12.11		1.96		0.31	

<sup>a</sup> Mortality determined by the method described by Robson and Chapman (1961).

<sup>b</sup> Assessment nets were gill nets made up of 300-foot panels of 2.0-, 2.25-, 2.5-, 2.75-, 3.0-, and 3.5-inch multifilament nylon mesh.

Table 9.—Mean total length (in)  $\pm$ 95% confidence intervals (CI) and length range for principal ages of all siscowet lake trout captured in the assessment of pre-recruit lake trout<sup>a</sup> in Michigan's Lake Superior management areas 2-7, 31 July-28 August 1996.

Management areas and parameters	Age (years)							
	7	8	9	10	11	12	13	14
<b>MI-2</b>								
Number	4	11	3	8	8	4	8	6
Mean length	13.7	15.8	15.2	17.6	18.5	20.6	19.8	21.8
$\pm$ 95% CI	1.0	1.0	5.2	1.8	1.7	1.1	1.9	1.7
Length range	13.0-14.7	13.6-17.7	13.3-18.1	15.6-22.1	15.5-21.0	19.7-21.6	18.1-25.5	18.5-23.9
<b>MI-3</b>								
Number	34	68	38	47	23	32	35	25
Mean length	14.4	15.6	16.4	17.6	19.1	20.2	20.7	21.7
$\pm$ 95% CI	0.5	0.4	0.4	0.8	1.0	0.8	0.8	1.1
Length range	12.5-17.9	12.8-19.9	13.6-20.4	14.2-29.8	15.4-23.5	15.6-25.1	16.8-26.0	17.5-27.9
<b>MI-4</b>								
Number	9	59	35	28	21	28	28	34
Mean length	14.7	16.0	16.8	17.8	18.5	20.8	22.0	22.2
$\pm$ 95% CI	1.8	0.5	0.6	0.7	1.0	1.0	1.0	1.0
Length range	9.1-17.7	12.4-23.3	13.5-20.5	15.2-21.7	15.1-23.4	14.7-26.0	17.7-26.5	17.1-27.0
<b>MI-5</b>								
Number	10	25	24	13	12	23	18	12
Mean length	15.3	15.7	17.1	17.8	18.5	19.0	21.3	21.9
$\pm$ 95% CI	1.6	0.6	0.9	1.1	0.8	1.2	1.3	1.3
Length range	11.5-18.3	11.0-21.7	12.9-22.5	14.9-22.0	16.8-21.5	13.6-24.3	16.5-29.2	18.5-25.4
<b>MI-6</b>								
Number	13	18	16	14	15	7	7	10
Mean length	15.9	17.6	19.0	19.9	20.6	20.3	21.7	21.2
$\pm$ 95% CI	1.2	0.9	0.8	1.3	1.2	0.5	2.2	1.7
Length range	11.8-18.4	13.7-20.1	15.6-22.5	17.1-25.5	17.0-24.5	19.8-21.2	17.8-24.7	18.4-26.0
<b>MI-7</b>								
Number	6	14	9	7	7	4	2	4
Mean length	19.0	18.8	19.9	20.8	21.5	22.2	20.1	21.3
$\pm$ 95% CI	2.5	0.9	1.3	1.4	2.3	3.5	1.8	1.1
Length range	16.8-24.0	16.5-22.2	17.2-22.9	18.8-23.0	19.3-26.7	19.4-24.9	19.9-20.3	20.7-22.5

<sup>a</sup> Assessment nets were gill nets made up of 300-foot panels of 2.0-, 2.25-, 2.5-, 2.75-, 3.0-, and 3.5-inch multifilament nylon mesh.

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